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**Kim et al.**

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(54) **HEAD-UP DISPLAY DEVICE AND VEHICLE HAVING THE SAME**

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***H04N 5/247*** (2006.01)
***H04N 5/232*** (2006.01)

(52) **U.S. Cl.**
CPC ..... ***G02B 27/0101*** (2013.01); ***H04N 5/23293*** (2013.01); ***H04N 5/247*** (2013.01); *G02B 2027/014* (2013.01); *G02B 2027/0123* (2013.01); *G02B 2027/0138* (2013.01); *G02B 2027/0141* (2013.01)

(58) **Field of Classification Search**
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See application file for complete search history.

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(57) **ABSTRACT**

A head-up display (HUD) device configured to project at least one of an image or a text on a windshield includes a display panel, a backlight module configured to emit light to the display panel, and an optical guide module configured to guide the at least one of the image or the text displayed on the display panel to the windshield. The backlight module includes a plurality of light sources configured to emit light to the display panel in different directions from one another such that the at least one of the image or text is independently projected on different regions of the windshield.

**23 Claims, 8 Drawing Sheets**

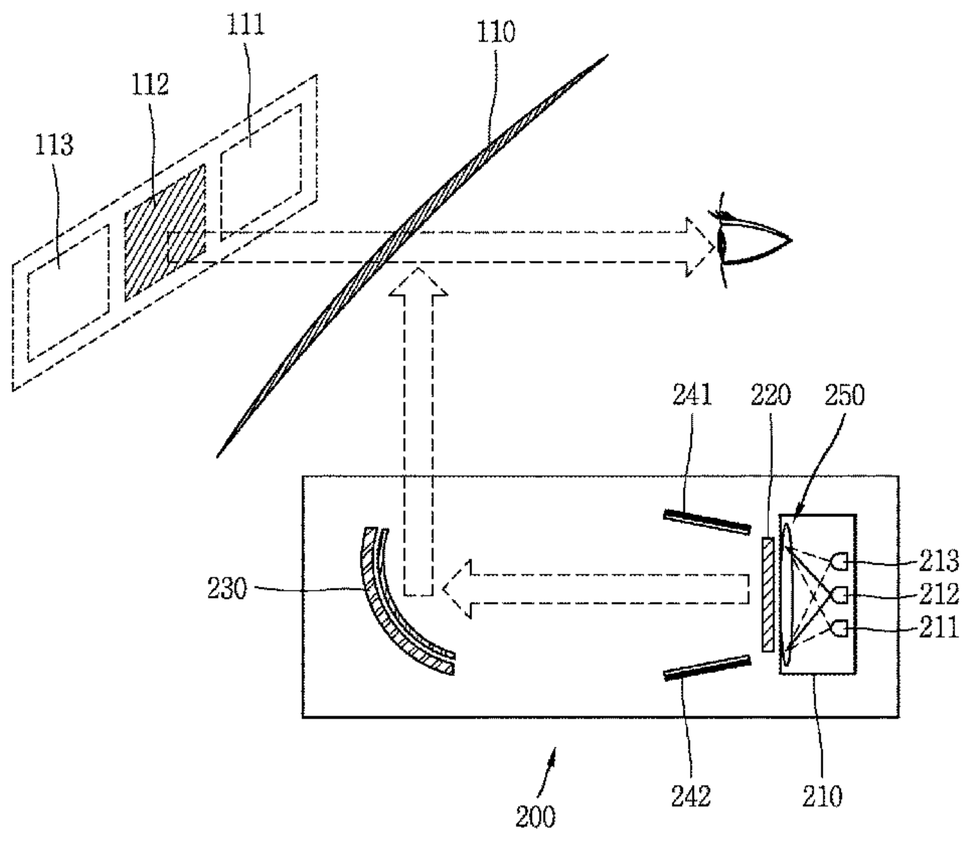

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FIG. 1

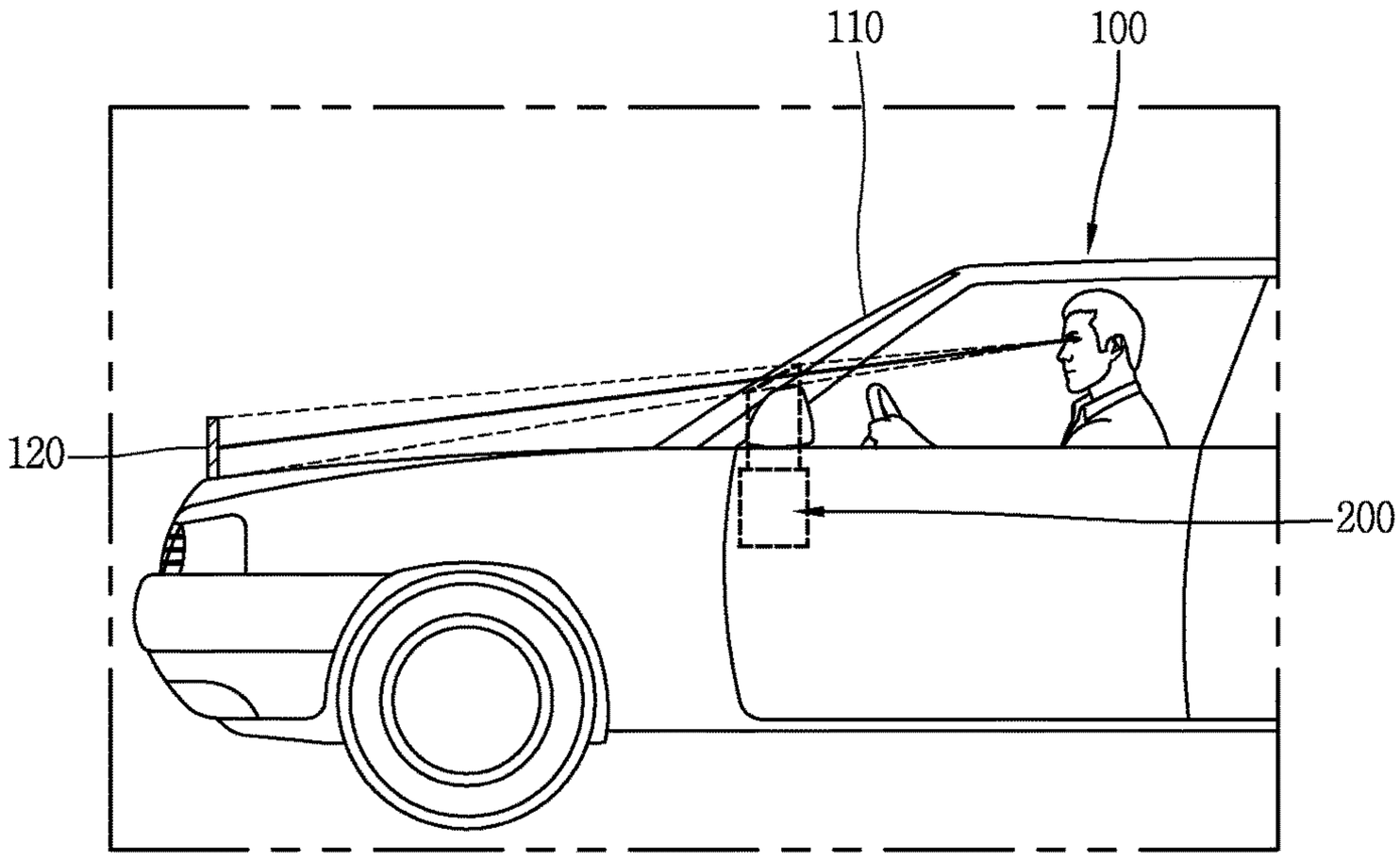

110
100
120
200

FIG. 2

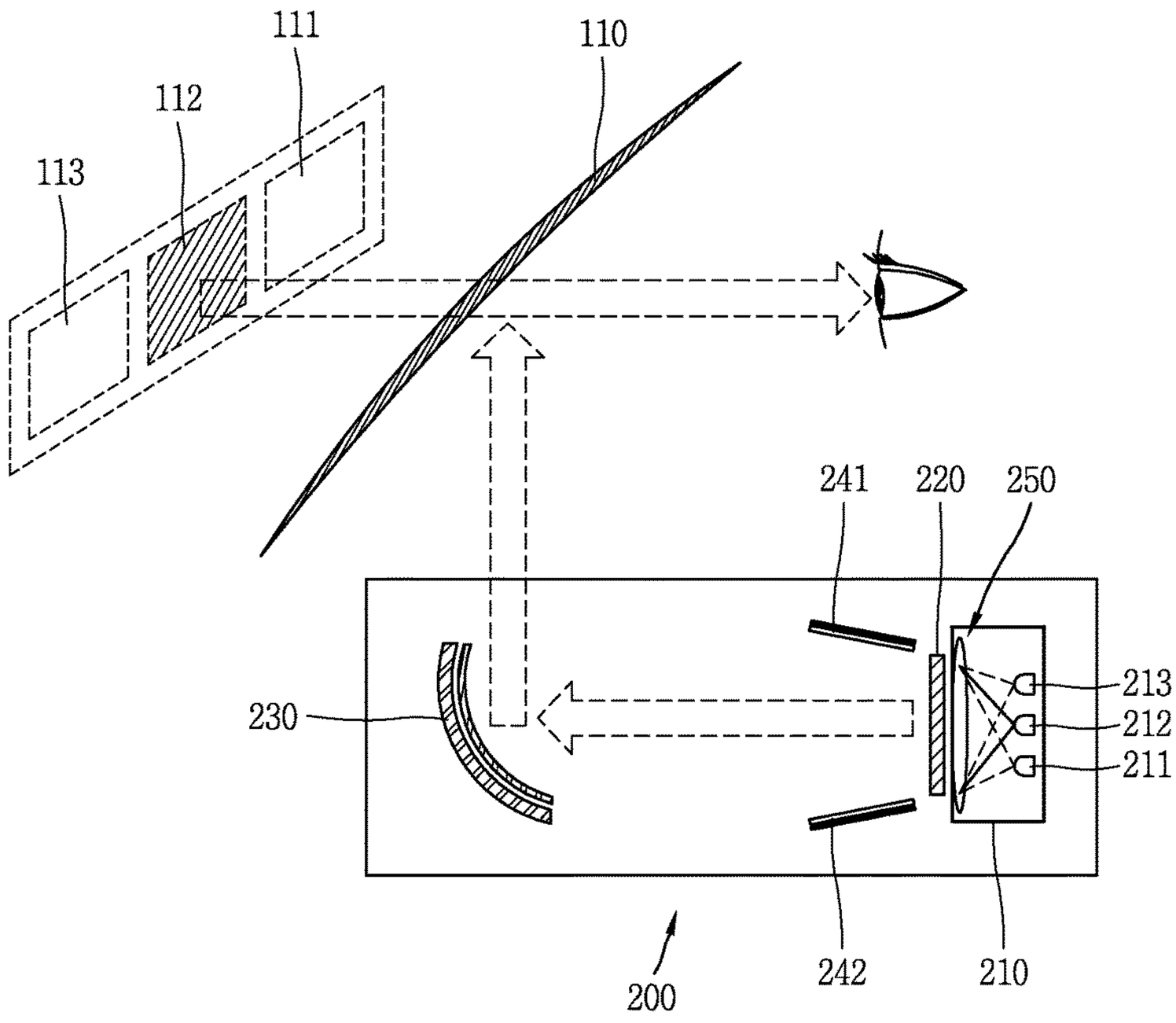

111
110
112
113
241
220
250
213
212
211
230
242
210
200

FIG. 3A

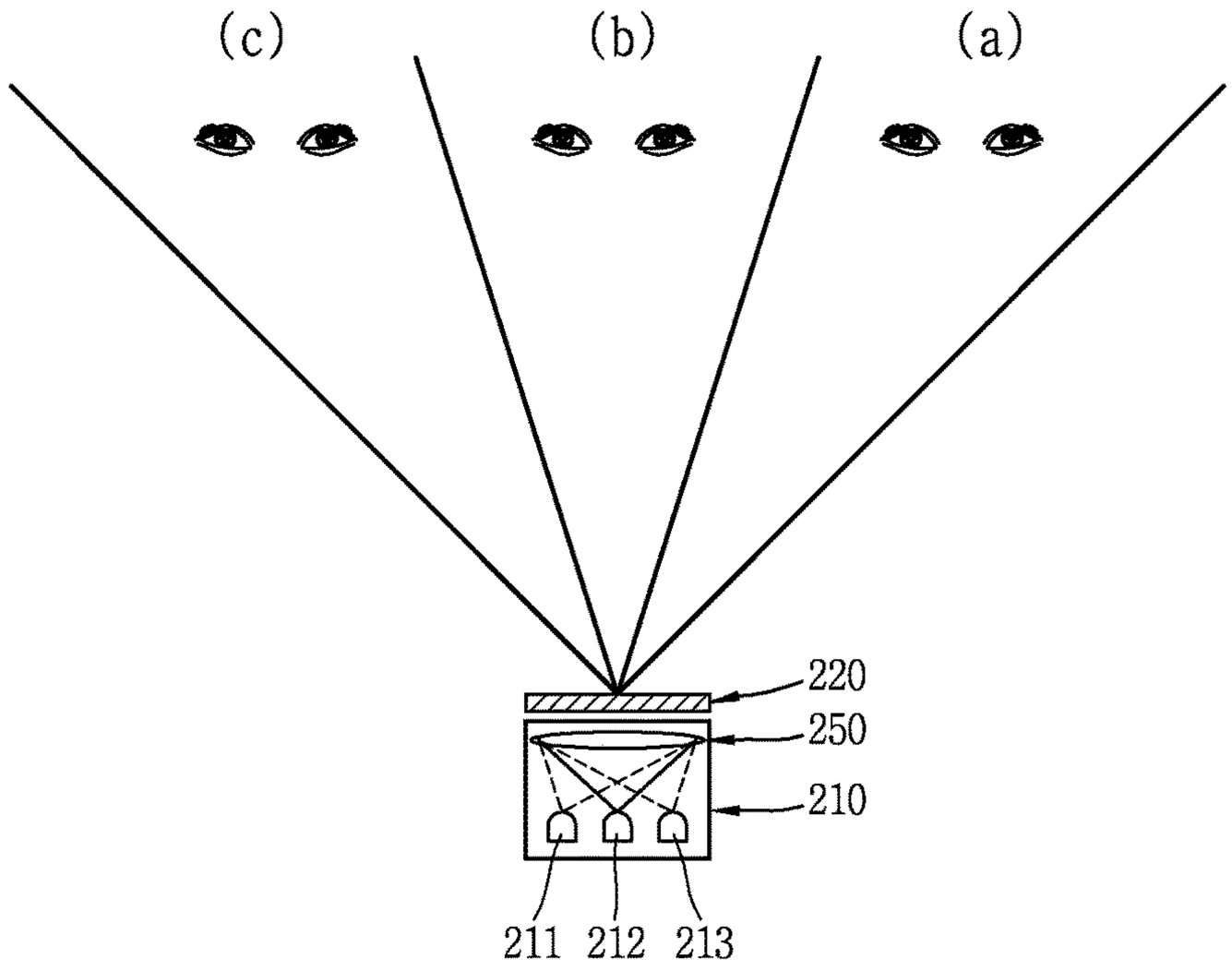



FIG. 3B

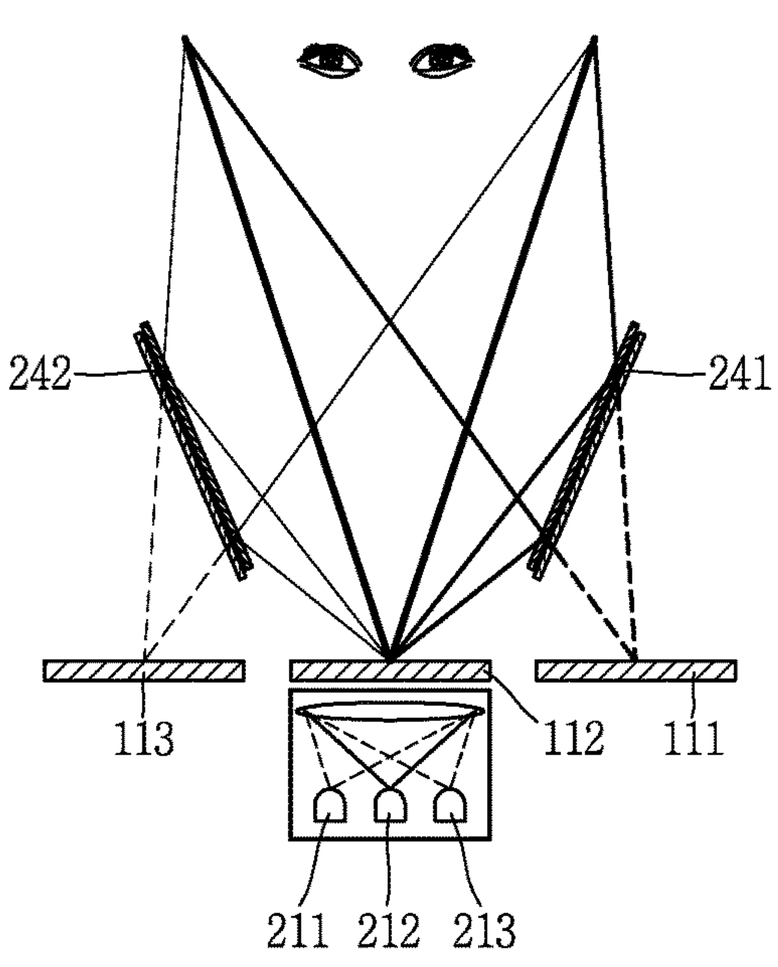


FIG. 4

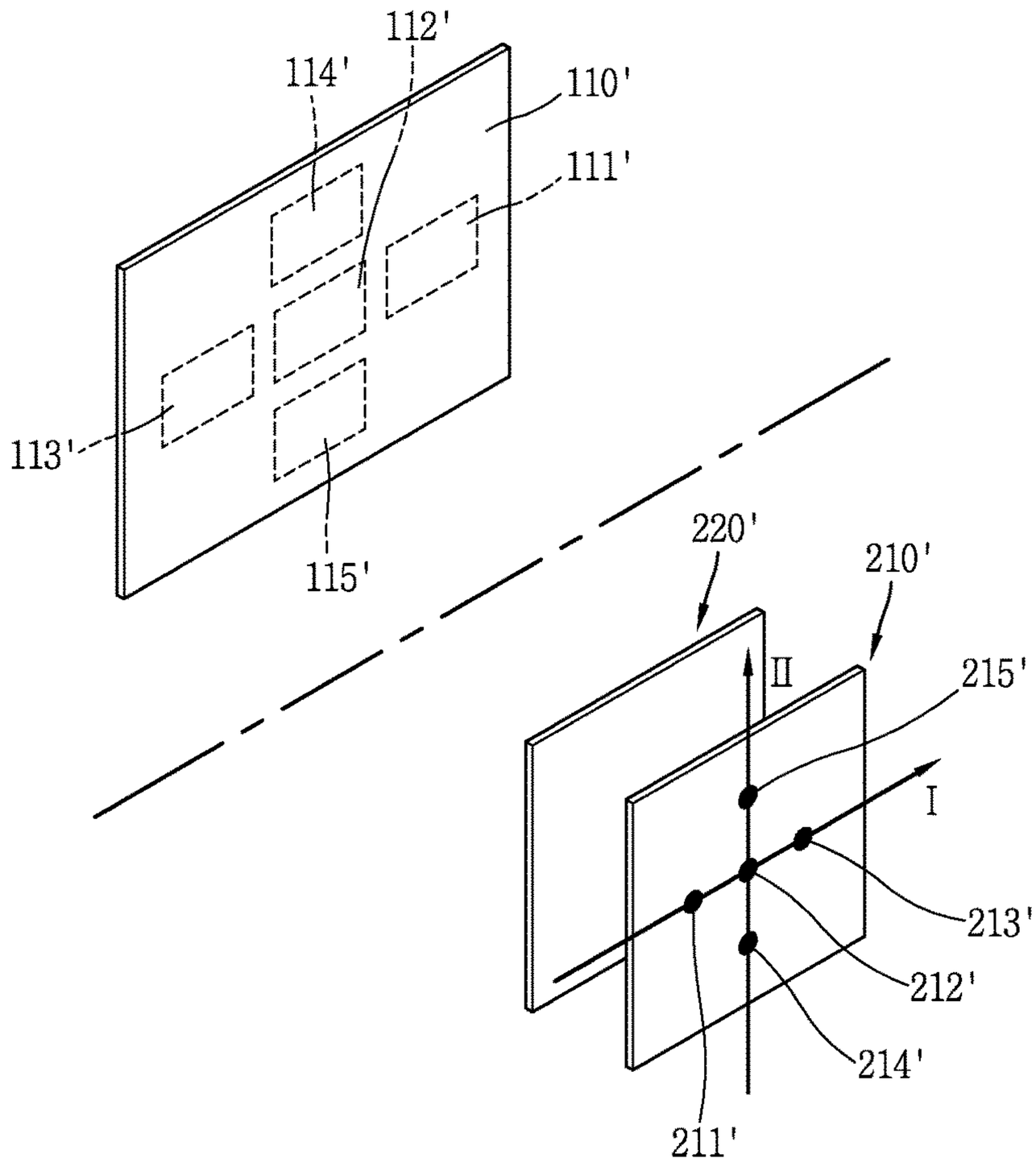


FIG. 5

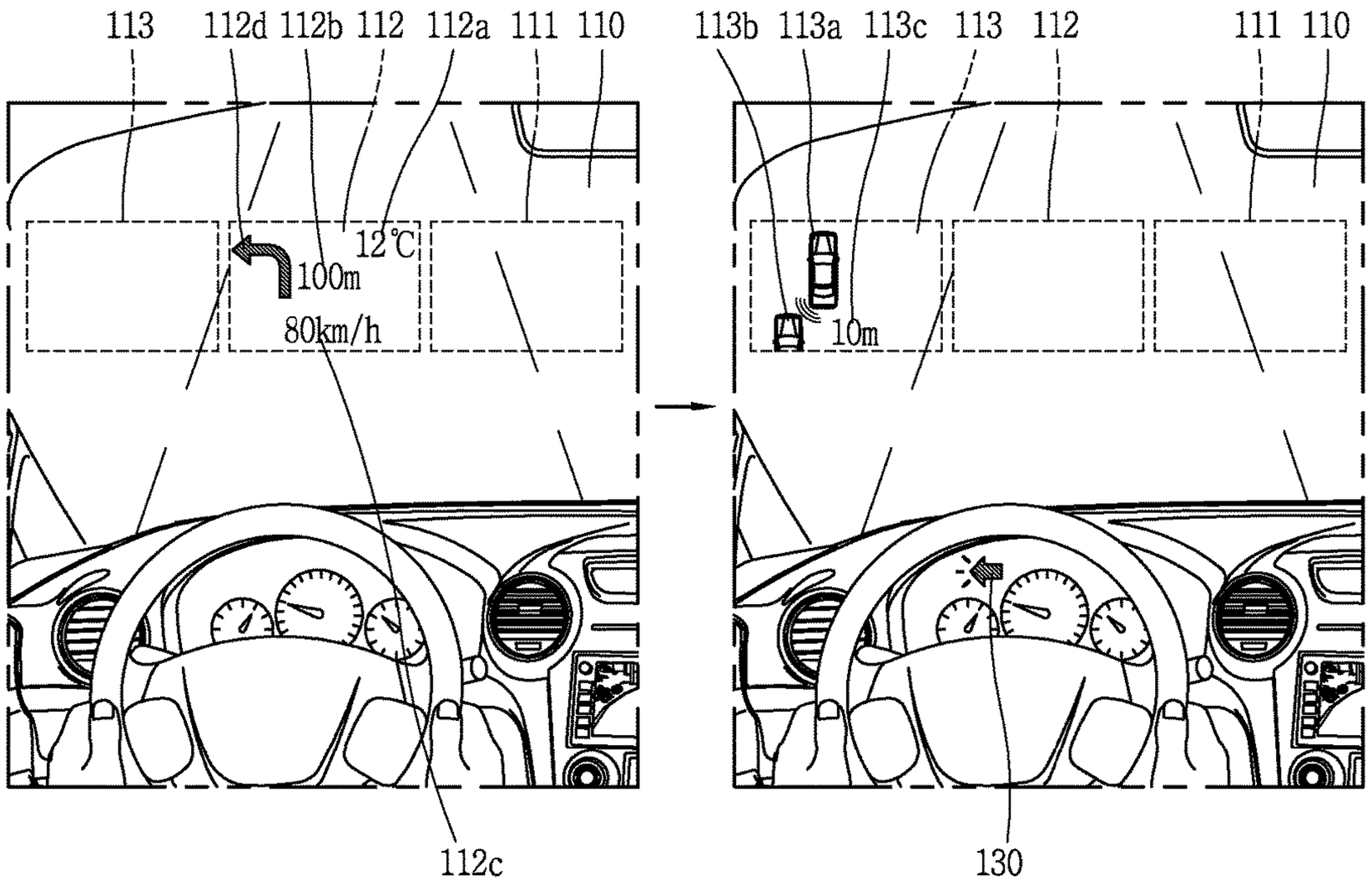

113
112d
112b
112
112a
111
110
12℃
100m
80km/h
112c
113b
113a
113c
113
112
111
110
10m
130

FIG. 6

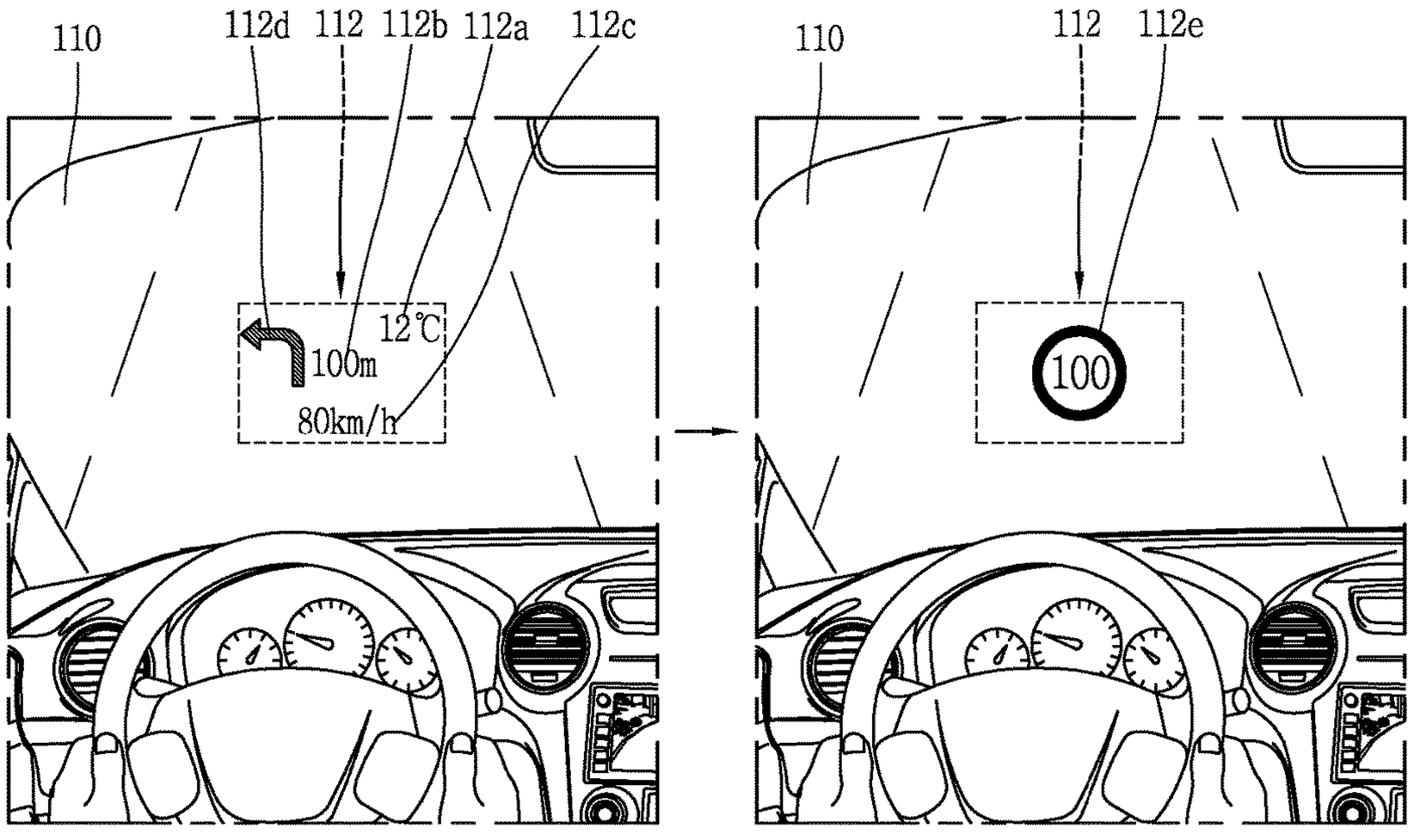

110
112d
112
112b
112a
112c
12℃
100m
80km/h
110
112
112e
100

FIG. 7

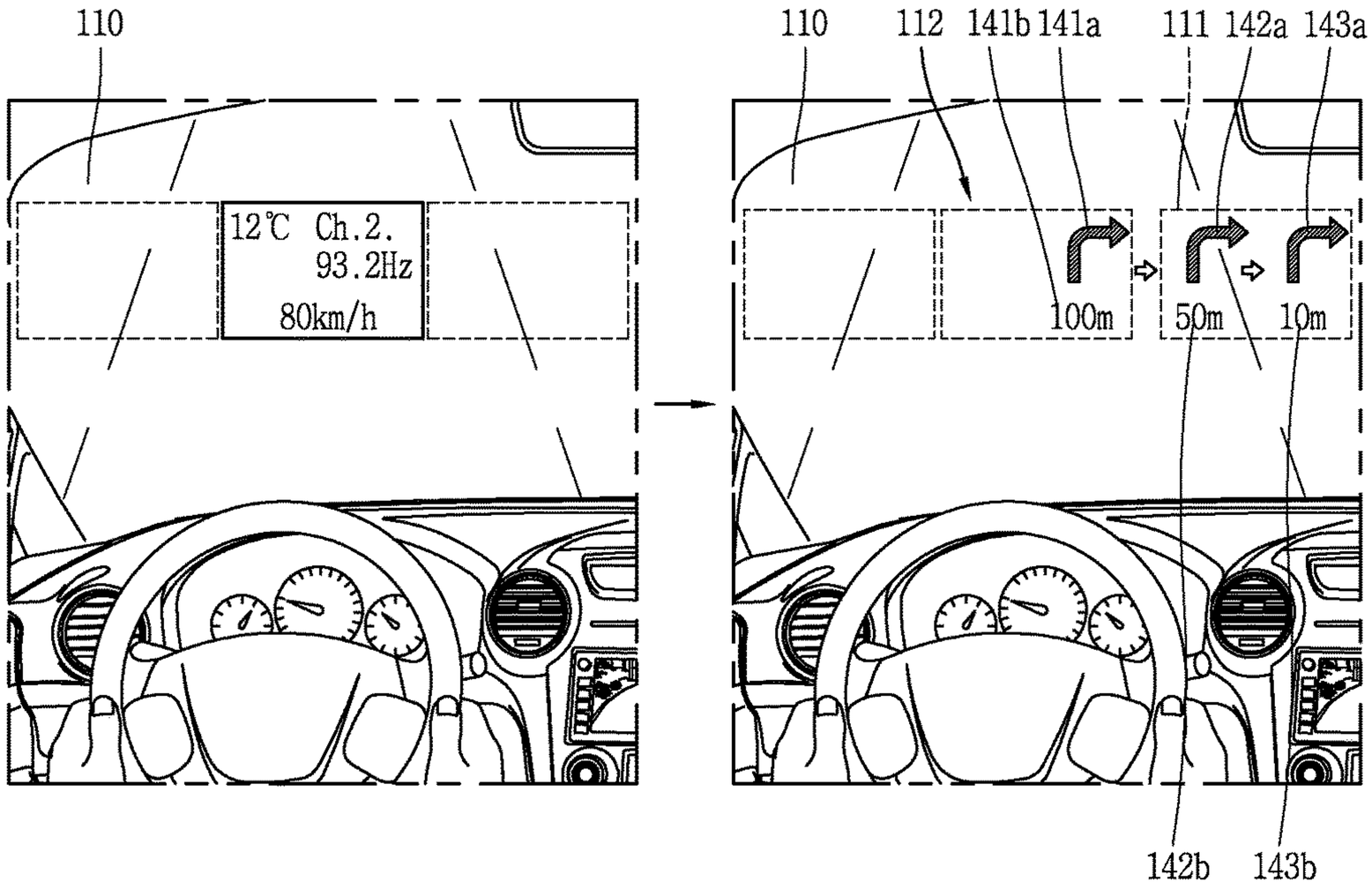

110
12℃ Ch.2.
93.2Hz
80km/h
110
112
141b
141a
111
142a
143a
100m
50m
10m
142b
143b

FIG. 8

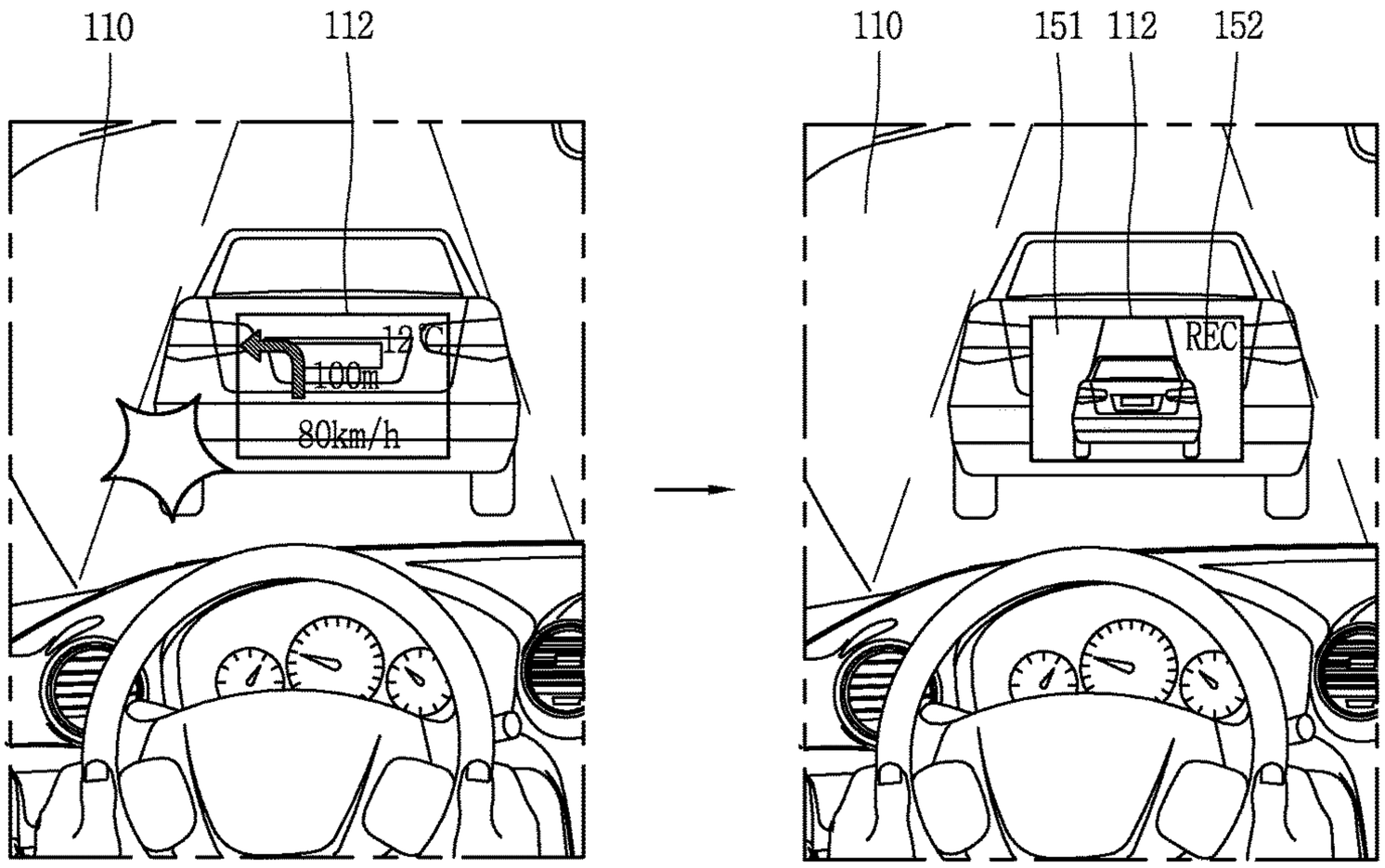
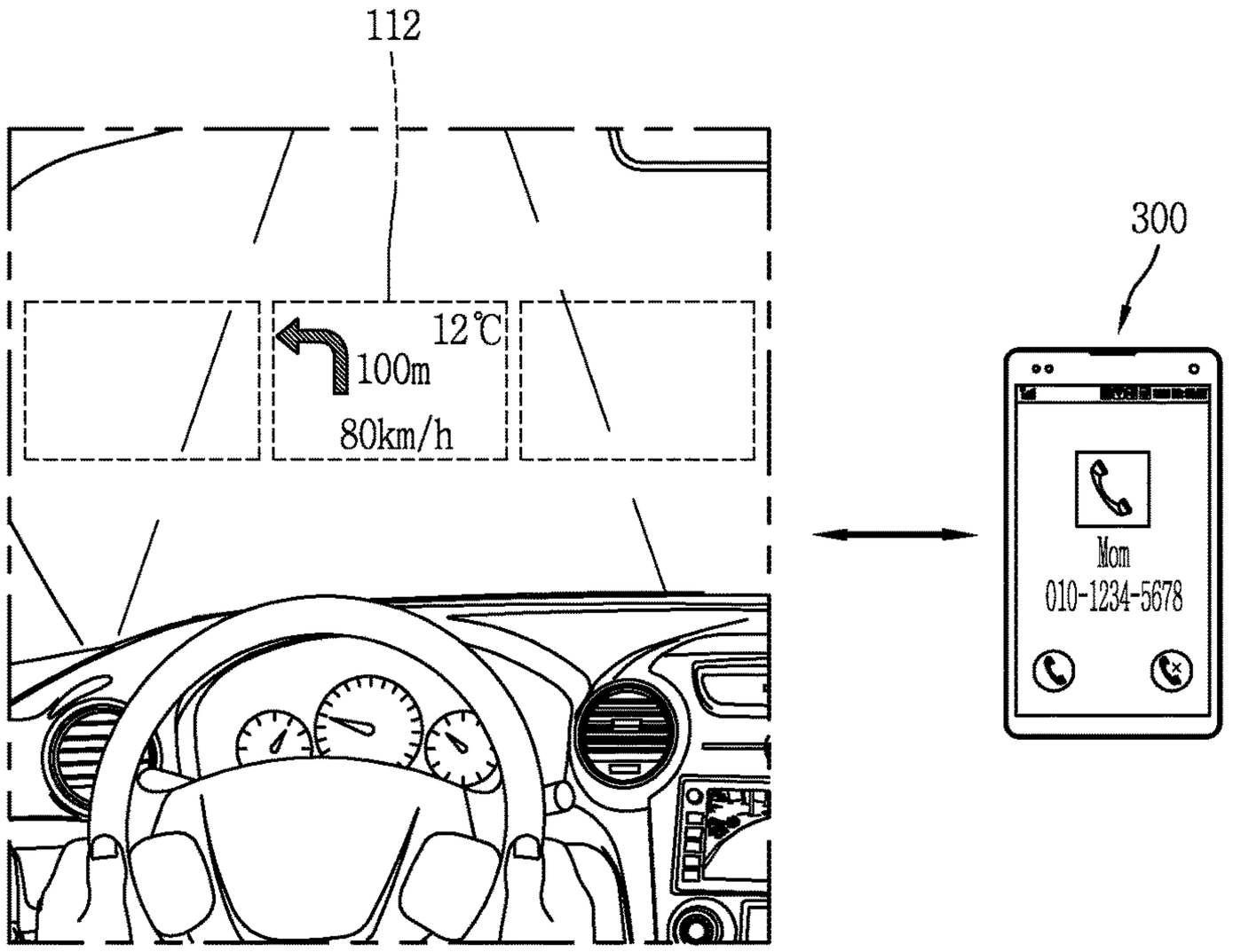

110
112
12℃
100m
80km/h
110
151
112
152
REC

FIG. 9


112
12℃
100m
80km/h
300
Mom
010-1234-5678

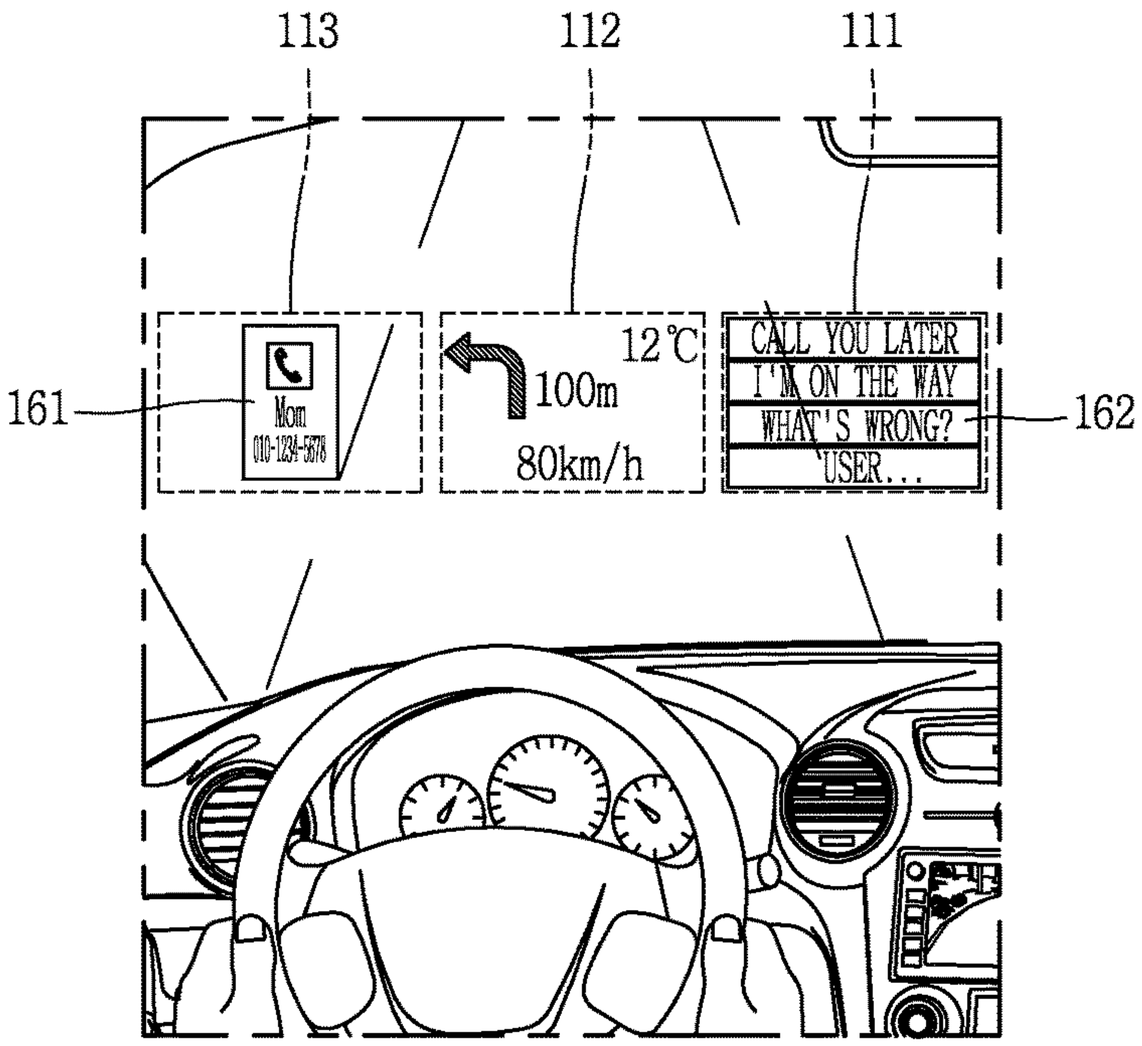

113
112
111
161
Mom
010-1234-5678
12℃
100m
80km/h
CALL YOU LATER
I'M ON THE WAY
WHAT'S WRONG?
USER...
162

FIG. 10

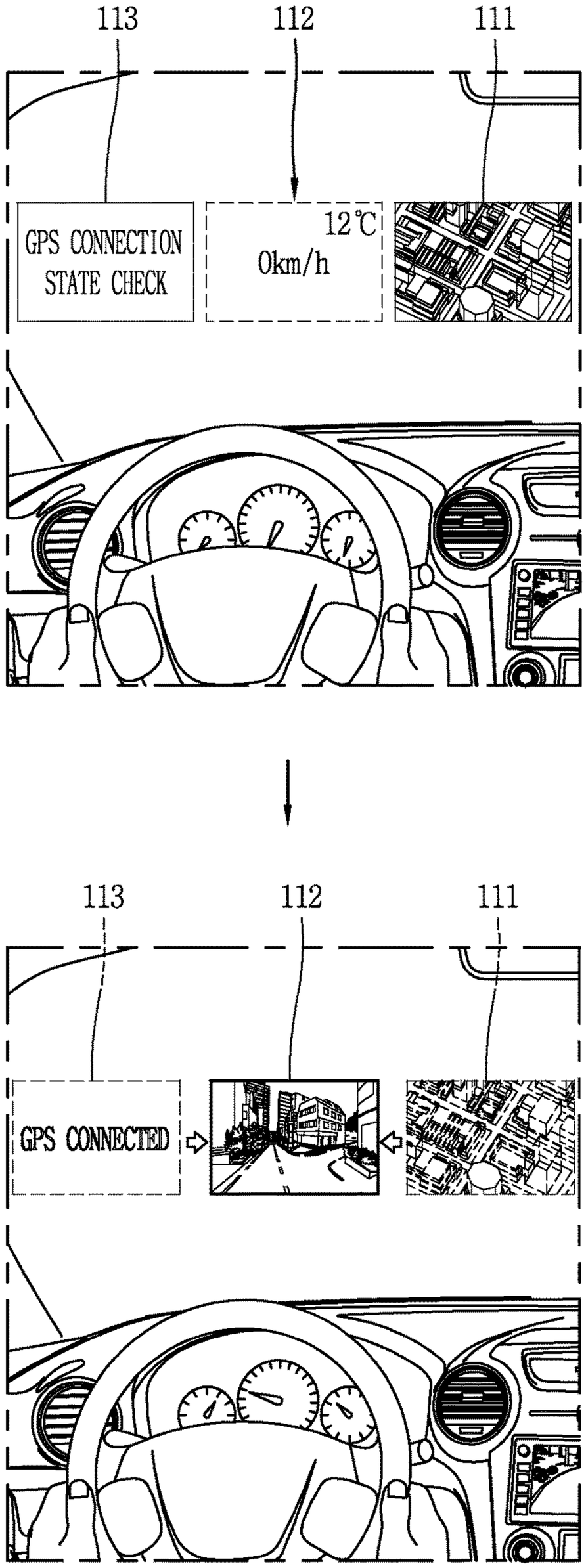
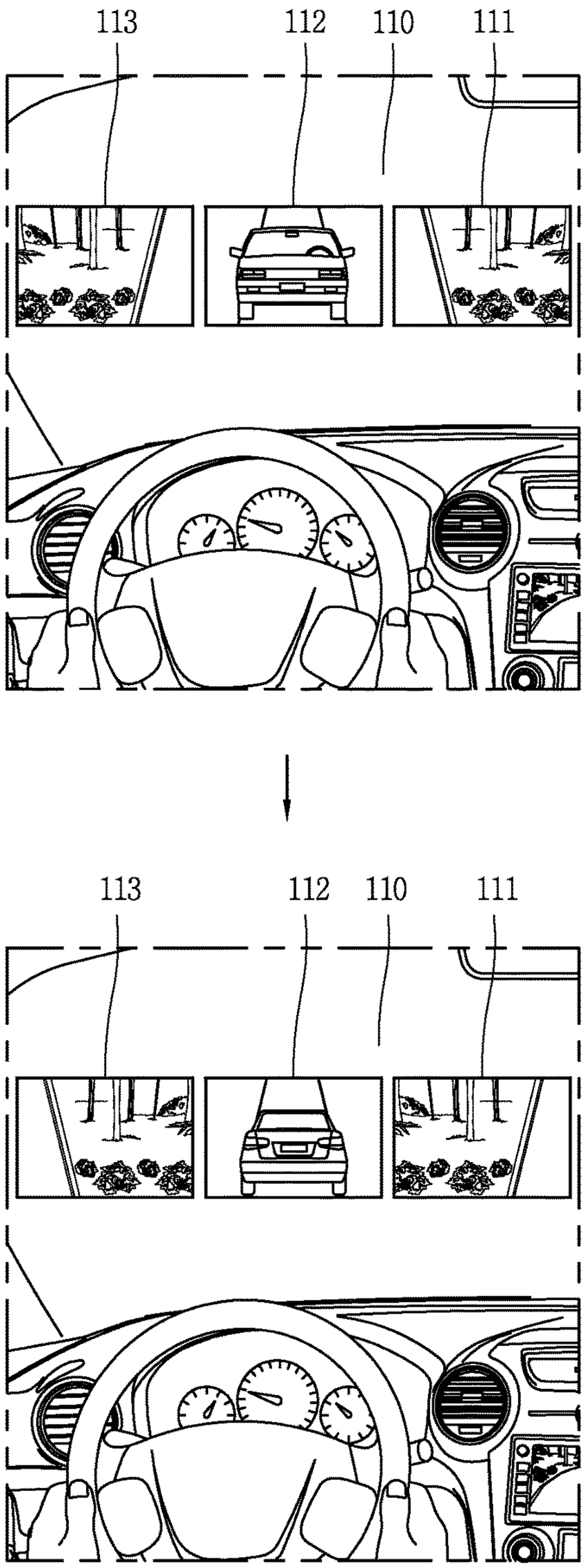

113
112
111
GPS CONNECTION STATE CHECK
12℃
0km/h
GPS CONNECTED

FIG. 11



# HEAD-UP DISPLAY DEVICE AND VEHICLE HAVING THE SAME

## CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority under 35 U.S.C. §119 to Korean Application No. 10-2014-0052760 filed on Apr. 30, 2014, whose entire disclosure is hereby incorporated by reference.

## BACKGROUND

1. Field

This specification relates to a head-up display device configured to display a driving (traveling) information image.

2. Background

Various driving assistance systems and devices are developed for convenience and safety of a driver of a vehicle. As part of the development, a head-up display (HUD) device has recently been mounted in a vehicle. The head-up display device is a next generation display device, which enables more effective transfer of driving information to a driver while the driver drives a vehicle.

The HUD has actually been developed to reduce inconvenience of an aircraft pilot who has to check an external reference, keeping a look down at instruments within a cockpit. Typically, a reference ratio of about 8:2 is maintained between an outside condition and an internal instrument during an instrument flight. However, almost 99% external data or more has to be referred to during a formation flight. Therefore, various types of required information are projected to the pilot's visual field for reference.

The motivation of the HUD development may equally be applied to an HUD for vehicle. A navigation provides a driver (or a user) with important information required for driving a vehicle, and thus the user has to frequently check such information. However, a navigation screen is not located at the front of the driver, which causes the driver's inconvenience in checking it and is likely to cause an accident while driving the vehicle.

The HUD device mounted to the vehicle allows the driver to check information required for driving without dispersing the driver's eyes from the front side. For example, the HUD device displays on a windshield driving information, such as a driving velocity, a driving distance, the number of revolutions (RPM) of an engine, and the like, and vehicle information such as a quantity of fuel and the like. With displaying such driving-related information on the windshield while driving the vehicle, the driver does not have to turn his or her eyes to a dash board having an instrument board and the like. This may result in prevention of an accident which may be caused due to not looking forward.

In recent time, the development of automotive technologies allows drivers to be provided with more information while they are driving their vehicles. However, the conventional HUD device has a limitation in a quantity of information which can be simultaneously provided. To overcome such limitation, a panel within the HUD device has to increase in size, which results in an increase in weight as well as the size of the HUD device.

Since there are many electronic components within a vehicle, the increase in the size increase of the HUD device is limited. Hence, there is a requirement for developing an HUD device which can have a reduced size and provide information more efficiently.



## BRIEF DESCRIPTION OF THE DRAWINGS

The embodiments will be described in detail with reference to the following drawings in which like reference numerals refer to like elements wherein:

FIG. **1** is a conceptual view illustrating a principle of a head-up display (HUD) device;

FIG. **2** is a conceptual view illustrating a structure of an HUD device in accordance with one exemplary embodiment of the present disclosure;

FIGS. **3**A and **3**B are conceptual views illustrating a principle of the HUD device illustrated in FIG. **2**;

FIG. **4** is a conceptual view illustrating a backlight module in accordance with another exemplary embodiment of the present disclosure; and

FIGS. **5** to **11** are conceptual views illustrating exemplary embodiments of an image displayed on an HUD device while a vehicle is driven.

## DETAILED DESCRIPTION

FIG. **1** is a conceptual view illustrating a principle of a head-up display (HUD) device **200**. A head-up display (HUD) device **200** according to one exemplary embodiment disclosed herein is mounted in a vehicle **100** and displays driving-related information on a windshield **110**. To this end, the HUD device **200** includes a communication unit, a controller, a display unit and the like.

An external server is connected to vehicles through networks. Examples of the networks include various types of wireless communication networks, such as wireless Internet networks, such as Wide Area Network (WAN), Wireless Broadband Internet (WiBro) and the like, and mobile telecommunication networks, such as Code Division Multiple Access (CDMA), Global System for Mobile telecommunication (GSM) and the like.

The external server collects and stores driving information relating to vehicles by communicating with the vehicles through such networks. When a specific vehicle **100** requests for driving information related to other vehicles **100**, the external server provides the specific vehicle **100** with the driving information related to vehicles adjacent to the specific vehicle **100**.

The driving information includes various types of driving-related information of each vehicle **100**, such as a destination, an estimated driving path toward a destination, a current position, current velocity, a velocity variation, a driving direction, changes in a driving direction and the like.

The server periodically receives and updates such information from the vehicles. Specifically, when there is a driving information request from a terminal mounted in a specific vehicle **100**, the server transmits the collected information to the terminal mounted in the specific vehicle **100** through an Internet or a communication network, such as a CDMA or GSM.

The terminal includes a terminal which is cooperative with a global positioning system (GPS) module installed in the vehicle **100** for receiving navigation messages sent from a GPS satellite and outputs graphic information on a display provided thereto, and various types of portable terminals. The communication module of the HUD device **200** may

perform data transmission and reception by being connected to the server or with a portable terminal connected to the server.

The controller transmits a current position of the vehicle **100** to the server, and receives driving information, such as traffic conditions of adjacent areas, from the server. The controller analyzes the driving information and outputs the analysis result through the display unit.

The controller analyzes GPS information, driving information and the like, and transmits such information to the server through the communication module. The GPS information includes information related to a current position, a start point, a destination and the like of the vehicle **100**. The driving information includes information related to velocity, a velocity variation, a lane change of the vehicle **100**.

The controller is connected to various sensors and structures of the vehicle **100** for collecting such information. The sensors include a proximity sensor, a velocity sensor, a temperature sensor, a pressure sensor, an accelerometer, and the like. The structures of the vehicle **100** include a handle, turn signals **130** (see FIG. **5**), a brake, a black box and the like.

Front, rear and side cameras may be mounted to the vehicle **100**. The controller **180** analyzes and stores image information collected by the cameras. The controller may output the image information received from the cameras on the windshield **110** or switch the image information into text information so as to output on the windshield **110**.

The controller processes image information related to left rear and right rear sides of the vehicle **100**, received from those cameras, and outputs the processed image information on the windshield **110**. When there is no change in a driving state, the driving information may not be output on the windshield **110**. For example, when the vehicle **100** is driven on the same lane at the same velocity, the driving information may not be output.

For the sake of explanation, it has been described that the images are output on the windshield **110**. However, the windshield **110** serves to reflect light projected by the HUD device **200**. A driver receives light reflected by the windshield **110** and recognizes that an image **120** is present in a viewing direction.

FIG. **2** is a view illustrating a structure of an HUD device **200** in accordance with one exemplary embodiment of the present disclosure. The HUD device **200** includes a display panel **220**, a backlight module or a light source **210** and an optical guide module.

The display panel **220** outputs driving information images. The display panel **220** outputs driving information by virtue of light, as a light source, emitted from the backlight module **210**. The display panel **220** may be configured by bonding a transistor substrate and a color filter substrate with liquid crystals interposed therebetween, and represent a different color of light for each pixel by adjusting transmittance of light using the liquid crystals.

The backlight module **210** is disposed behind the display panel **220** to emit light toward the display panel **220**. The backlight module **210** disclosed herein includes a plurality of backlight units which emit light to the display panel **220** in different directions from one another and may comprise a plurality of light emitting devices (LEDs).

This exemplary embodiment illustrates that the backlight module **210** includes first to third backlight units **211**, **212** and **213** arranged along one direction with being spaced apart from one another. The second backlight unit **212** is disposed to overlap a center of the display panel **220**, and the first backlight unit **211** and the third backlight unit **213** are spaced apart from each other in opposite directions with the second backlight unit **212** therebetween.

The first to third backlight units **211**, **212** and **213** operate independently. For example, it may be possible to operate one or all of the first to third backlight units **211**, **212** and **213**. In addition, the first to third backlight units **211**, **212** and **213** may operate in an alternating manner. Here, a short alternating interval may be set such that all of three images seem to be displayed on the windshield **110**.

The first to third backlight units **211**, **212** and **213** are configured to emit light to the display panel **220** in different directions from one another. As illustrated in FIG. **2**, an optical axis of the second backlight unit **212** is perpendicular to the display panel **220**, and the optical axes of the first and third backlight units **211** and **213** are inclined from the display panel **220**. The first backlight unit **211** and the third backlight unit **213** are spaced apart from each other in the different directions based on the second backlight unit **212**. Hence, light emitted from the first backlight unit **211** and light emitted from the third backlight unit **213** are inclinedly incident onto the display panel **220** in different directions. Alternatively or additionally, each backlight unit may be moveable and/or rotatable to change the angle of incidence.

The first to third backlight units **211**, **212** and **213** may generate different images on the display panel **220**, respectively. For example, the second backlight unit **212** may generate navigation information on the display panel **220** and the first and third backlight units **211** and **213** may generate information received from a mobile terminal on the display panel **220**.

This embodiment has illustrated that the backlight module **210** includes the first to third backlight units **211**, **212** and **213** for the sake of explanation, but the present disclosure may not be limited to the number of backlight units. If a backlight unit is provided in plural, the teaching of the present disclosure will be applied irrespective of the number.

The optical guide module guides light transmitted through the display panel **220** toward the windshield **110**. The optical guide module may include a plurality of mirrors and lenses. This embodiment exemplarily illustrates that the optical guide module includes a main mirror **230** which reflects an image displayed on the display panel **220** to the windshield **110**, and sub mirrors which are inclinedly disposed from a central axis of the display panel **220**.

The sub mirrors may include a first sub mirror **241** which reflects light emitted from the first backlight unit **211** toward the main mirror **230**, and a second sub mirror **242** which reflects light emitted from the third backlight unit **213** toward the main mirror **230**. In other words, the first sub mirror **241** is located on an optical path of the light emitted from the first backlight unit **211** so as to reflect an image, which is output on the display panel **220** by the first backlight unit **211**, toward the main mirror **230**. Similarly, the second sub mirror **241** is located on an optical path of the light emitted from the third backlight unit **213** so as to reflect an image, which is output on the display panel **220** by the third backlight unit **213**, toward the main mirror **230**.

According to the teachings of the present disclosure, the first backlight unit **211** generates a first image on a first region **111** of the windshield **110**, the second backlight unit **212** generates a second image on a second region **112** of the windshield **110**, and the third backlight unit **213** generates a third image on a third region **113** of the windshield **110**.

The first and second sub mirrors **241** and **242** may allow all of the first to third images generated by the first to third backlight units **211**, **212** and **213** to be displayed on the second region **112** of the windshield **110**. To this end, the

first and second sub mirrors **241** and **242** may be configured to be tiltable. The controller of the HUD device **200** may control tilt angles of the first and second sub mirrors **241** and **242** according to a control signal.

With the adjustment of the tilt angles of the first and second mirrors **241** and **242**, the first and third images generated by the first and third backlight units **211** and **213** may all be displayed on the second region **112** of the windshield **110**. In addition, as illustrated previously, the second image generated by the second backlight unit **212** may also be displayed on the second region **112** of the windshield **110**.

One exemplary embodiment of a control method using this structure will be explained in detail later with reference to FIG. **10**. Between the display panel **220** and the backlight module **210** may be disposed a lens array **250** which gathers (collects) light emitted from the backlight units toward the display panel **220**. The lens array **250** serves to enlarge or reduce images, which are incident from different directions, into appropriate sizes, and adjust a focal point.

Meanwhile, a plurality of reflection mirrors may be provided between the display panel **220** and the main mirror **230** to extend an advancing path of light. If a depth of field of a driving information image displayed on the windshield **110** is shallow, the other portions except for a specific portion may be outfocused (or blurred). Here, the reflection mirrors may be used to bypass the advancing path of the light so as to increase the depth of field of the driving information image. Accordingly, the image with sharp details and improved visibility can be obtained.

FIGS. **3**A and **3**B are views illustrating a principle of the HUD device illustrated in FIG. **2**. In more detail, FIG. **3**A illustrates a state when sub mirrors are not provided, and FIG. **3**B illustrates a state where the sub mirrors are provided. As illustrated in FIG. **3**A, the lens array **250** and the backlight module **210** are disposed behind the display panel **220**. The backlight module **210** includes the plurality of backlight units **211**, **212** and **213** which are spaced apart from one another and independently operate.

The first backlight unit **211** is disposed at one side and the third backlight unit **213** is disposed at the other side based on the second backlight unit **212**. Light emitted from the first backlight unit **211** is ongoing toward the other side through the display panel **220** and light emitted from the third backlight unit **213** is ongoing toward the one side through the display panel **220**. Meanwhile, light emitted from the second backlight unit **212** goes along by being perpendicularly transmitted through the display panel **220**. Therefore, the clearest image can be viewed at a position (a) when the first backlight unit **211** operates, and at a position (b) when the second backlight unit **212** operates, and at a position (c) when the third backlight unit **213** operates.

As illustrated in FIG. **3**B, sub mirrors are arranged at the front of the display panel **220**. The sub mirrors are inclined from a central axis of the display panel **220** so as to reflect light, which is ongoing with being inclined to one side, toward the user located at the position (b). Accordingly, the user located at the position (b) may view an image as follows.

First, the second backlight unit **212** is located at a center of the display panel **220**. Hence, the user recognizes that the second image generated by the second backlight unit **212** is displayed on the second region **112** in a forward direction.

Meanwhile, the first sub mirror **241** is located on an optical path of the light emitted from the first backlight unit **211**. The user senses light reflected by the first sub mirror **241**. Therefore, the user recognizes that the first image generated by the first backlight unit **211** is displayed on the first region **111**, which is located at a rear side of the first sub mirror **241** based on the user's vision viewing the first sub mirror **241**.

Similar to this, the second sub mirror **242** is located on an optical path of the light emitted from the third backlight unit **213**. Since the user senses light reflected by the second sub mirror **242**, the user recognizes that the third image generated by the third backlight unit **213** is displayed on the third region **113**, which is located at a rear side of the second sub mirror **242** based on the user's vision viewing the second sub mirror **242**.

At the position (b), the user feels or perceives that the second image is displayed in the forward direction when the second backlight unit **212** operates, that the first mage is displayed at one side of the second image when the first backlight unit **211** operates, and that the third image is displayed at the other side of the second image when the third backlight unit **213** operates. Therefore, the user may view the displayed image at the position (b) without having to move, and view a different image according to a backlight unit in an operating state.

To implement this, the controller may change image information displayed on the display panel **220** to correspond to the operation of each of the plurality of backlight units. For example, the controller may control the display panel **220** to output first image information thereon when the first backlight unit **211** operates, and to output second image information thereon when the second backlight unit **212** operates. The plurality of images can be viewed independently or simultaneously by the user.

In order to allow the user to view the plurality of images in the independent manner, when one of the plurality of backlight units operates, the other backlight units may not operate. Here, image information corresponding to the backlight unit which operates may be output on the display panel **220**.

In order for the user to view a plurality of images, the controller may control the display panel **220** to change image information to correspond to the operation of each of the plurality of backlight units. The controller may sequentially operate each of the plurality of backlight units with predetermined time intervals. Accordingly, one backlight unit repeats output and non-output, and a non-output time is generated between the output and the non-output. In order for the user to recognize an image without discontinuity, the non-output time is set within a preset time.

When the number of display regions output on the windshield **110** increases, the controller may reduce an operating time of each of the plurality of backlight units. For example, in an activated state of all of the first to third backlight units **211**, **212** and **213**, the controller may sequentially operate the first to third backlight units **211**, **212** and **213** with a preset time interval. The preset time interval may be set to be inversely proportional to the number of backlight units in the activated state.

Meanwhile, each of images output respectively on the plurality of display regions may be image information belonging to a different category. The image information belonging to the different category may be related to information received from a different source. For example, driving information, camera information, navigation information, communication information (call, text, etc.) and the like may be output on different regions. To this end, the controller may control the image information output on the display panel **220** based on information received from

different sources, and control an operation of each backlight unit based on the image information.

FIG. **4** is a view illustrating a backlight module in accordance with another exemplary embodiment of the present disclosure. A backlight unit **210'** includes first to third backlight units **211'**, **212'** and **213'** arranged along a first direction I, and fourth and fifth backlight units **214'** and **215'** arranged along a second direction II intersecting with the first direction I. Although not illustrated, sub mirrors may be provided in all directions at the front of the display panel **220'**. Each of the sub mirrors is provided on an optical path of light emitted from each of the first, third, fourth and fifth backlight units **211'**, **213'**, **214'** and **215'** so as to reflect an image displayed on the display panel **220'** by the corresponding backlight unit toward a main mirror (not illustrated).

The method of outputting images by use of the first to fifth backlight units **211'**, **212'**, **213'**, **214'** and **215'** is the same as illustrated in FIGS. **2** to **3**B. According to this exemplary embodiment, images displayed may extend even in a vertical direction, which may allow for efficiently providing more information to the user. As illustrated in FIG. **4**, the first and third regions **111'**, **112'** and **113'** are located in a horizontal direction, and fourth and fifth regions **114'** and **115'** are located in the vertical direction.

FIGS. **5** to **11** are views illustrating exemplary embodiments of an image displayed on the HUD device **200** while the vehicle **100** is driven. Hereinafter, images displayed on the windshield **110** will be described in detail with reference to FIGS. **5** to **11**.

Images displayed in the following embodiments are output by the aforementioned HUD device **200**. For example, a first image may be projected by the first backlight unit **211**, a second image may be projected by the second backlight unit **212**, and a third image may be projected by the third backlight unit **213**. The principle that the image is projected on the windshield **110** has been previously described in detail. Therefore, the following description will be given, focusing on an image displayed.

FIG. **5** illustrates an embodiment in which an image changes in response to a turn-on of a turn signal **130**. Three adjacent display regions are present on the windshield **110**. A second region **112** for displaying the second image is present at a center. A first region **111** for displaying the first image is present at a right side of the second region **112**, and a third region **113** for displaying the third image is present at a left side of the second region **112**.

A state prior to a generation of an event is illustrated in the left drawing of FIG. **5**. As illustrated, a driving state is displayed only on the second region **112** without displaying any image on the first and third regions **111** and **113**. Navigation-related information may be displayed on the second region **112**. For example, a current driving velocity **112***c*, a path guide image **112***d*, a distance **112***b* until the next guidance (notification, notice, etc.) and the like, all associated with the vehicle **100**, may be displayed on the second region **112**. Also, a current temperature **112***a*, current atmospheric pressure and the like may also be displayed on the second region **112**. A combination or arrangement of those information displayed may be changeable by the user. The displayed information may be in the form of text or image.

A state upon a generation of a specific event is illustrated in the right drawing of FIG. **5**. This embodiment assumes an event that the vehicle **100** approaches from a left rear side. Regions viewed through rearview mirrors also include blind spots, and thus it may be likely to occur an accident upon changing a lane. Accordingly to this embodiment, however, such accident can be prevented in advance.

The controller of the HUD device **200** according to this embodiment controls an image based on various types of information which are transmitted from sensors and turn signals **130** (see FIG. **5**). When the driver switches on the turn signal **130**, it is necessary to check whether or not another vehicle is present in a direction indicated by the turn signal **130**. Here, the controller analyzes information sensed by a sensor mounted at the rear or side surface of the vehicle **100**, and displays approach or non-approach of another vehicle on the windshield **110**.

The displayed information may be in the form of text or image. For example, when the approach of another vehicle is sensed, the HUD device **200** may display a warning text or a vehicle image notifying "there is another vehicle in a direction to turn" on the windshield **110** to call the user's attention. In this embodiment, when the approach of the another vehicle is sensed, an image **113***a* of the currently-driving vehicle, an image **113***b* of the another vehicle and an image including distance information **113***c* between the two vehicles may be displayed on the windshield **110**.

For helping more intuitive sensing, a display region may be changeable according to circumstances. For example, when desiring to change a current lane to a left lane, if a vehicle **100** located at a left rear side is sensed, event generation information is displayed on the third region **113**. Similarly, when desiring to change a current lane to a right lane, if a vehicle **100** located at a right rear side is sensed, the event generation information is displayed on the first region **111**.

To implement this, the controller may control a backlight unit, which outputs an image in a direction corresponding to a turn signal, of the plurality of backlight units, in response to an operation of the turn signal. Along with this, the controller may control image information output on the display panel **220** based on data sensed by a detection sensor. The detection sensor is provided at at least one side of the vehicle to detect an object (vehicle, person, etc.) surrounding the detection sensor.

An image of each region may be independently displayed in this embodiment. For example, event generation information may be displayed on the third region **113**, and navigation information may be displayed on the second region **112**, independent of the event generation information. As aforementioned, the image on each region may be projected by a different backlight unit.

FIG. **5** exemplarily illustrates that when the approach of the another vehicle is sensed, the second backlight unit **212** in the operating state is paused, the navigation information output on the second region **112** disappears, and then the third backlight unit **213** operates so as to output the event generation information notifying the approach of the another vehicle on the third region **113**.

FIG. **6** illustrates an image when a velocity limit signal or an emergency condition signal is received through the communication unit. When the velocity limit signal or the emergency condition signal is received (hereinafter, referred to as "event generation"), a driving information image which is being output is switched into a warning image or text.

An image prior to the event generation is illustrated in the left drawing of FIG. **6**. As illustrated, a driving state is output merely on the second region **112**. Navigation-related information may be displayed on the second region **112**. For example, a current driving velocity **112***c*, a path guide image **112***d*, a distance **112***b* until the next guidance (notification,

notice, etc.) and the like, all associated with the vehicle, may be displayed on the second region **112**. Also, a current temperature **112***a*, current atmospheric pressure and the like may also be displayed on the second region **112**. A combination or arrangement of those information displayed may be changeable by the user.

An image after an event generation is illustrated in the right drawing of FIG. **6**. In this embodiment, the event may refer to a case of receiving a velocity limit signal through the communication unit due to an entry into a velocity limit zone or being close to an overspeed control camera.

Upon such event generation, the driving information image which is being output is switched into a warning. The warning may be output as the driving information image fades in or out, or output as the driving information image is flickered. The warning may be displayed brighter than the driving information image. To this end, the controller adjusts an output of the second backlight unit **212**. In other words, when an event is generated, the controller outputs a warning image by controlling the second backlight unit **212**. Here, brightness of the image increases by increasing power supplied.

FIG. **7** illustrates a driving path guide image in accordance with one embodiment disclosed herein. When the vehicle **100** approaches a guide point, a guide image **141***a* is output on the second region **112**. A distance **141***b* from the guide point is output below or above the image **141***a*.

When the vehicle **100** moves closer to the guide point, an image **142***a* and a distance **142***b*, which are associated with the image **141***a* and the distance **141***b*, respectively, are output on a region adjacent to the second region **112**, namely, on the first region **111**. The previously-output image **141***a* and distance **141***b* may disappear when the recently-output image **142***a* and distance **141***b* are output.

When the vehicle **100** moves much closer to the guide point, an image **143***a* and a distance **143***b*, which are associated with the image **142***a* and the distance **142***b*, respectively, are output on another positions within the adjacent region. Accordingly, the driver can recognize that the vehicle gets closer to the guide point. The previously-output image **142***a* and distance **142***b* may also disappear when the recently-output image **143***a* and distance **143***b* are output.

FIG. **7** exemplarily illustrates an output of a right-turn guide image.

According to the aforementioned control method, as the vehicles is closer to the guide point, the right-turn guide image is moved to right, such that the driver can more intuitively recognize that it is near the time to make a right turn. A control method similar to this is applied to a left-turn guide image. That is, the left-turn guide image seems to move to left as the guide point gets closer.

FIG. **8** illustrates an image when an impact is imminent to the vehicle **100**. When an impact is imminent to a front side of the vehicle **100**, a front camera is activated to record such condition, and a graphic object **152** indicating (or notifying) the ongoing recording is output on the windshield **110**. The controller may display a recorded image **151** on the windshield **110**. Similarly, when an impact is imminent to a rear side of the vehicle **100**, a rear camera is activated to record such condition, and the graphic object **152** indicating the ongoing recording is output on the windshield **110**. Here, the controller may display the recorded image **151** on the windshield **110**.

FIG. **9** illustrates an image upon using a mobile terminal during driving of the vehicle **100**. The communication unit of the HUD device **200** performs data transmission and reception with an external device. Here, the external device includes a communication server, a mobile terminal **300** and the like. When an incoming call or a text message is received in the mobile terminal **300** during driving, the controller outputs an image, which is displayed on a display of the mobile terminal **300**, on the windshield **110**.

As illustrated in FIG. **9**, a driving information image may be displayed on the second region **112**, and incoming call information **161** may be displayed on the third region **113**. The user may input a control command through a voice recognition unit or a manipulation unit. A selectable sub menu item **162** may be output on the first region **111** of the windshield **110**.

When the user inputs a voice signal corresponding to the sub menu item **162**, the controller transfers an associated command to the mobile terminal **300**. Similarly, the user may select the sub menu item **162** using the manipulation unit. When the sub menu item **162** is selected, the controller transfers the associated command to the mobile terminal **300**.

FIG. **10** illustrates an image when the vehicle **100** starts to be driven or the HUD device **200** is turned on. State information related to the vehicle **100**, traffic information and the like may be selectively displayed on the second region **112**. A map showing surroundings of a current position may be displayed on the first region **111** and a graphic object or a notification message may be displayed on the third region **113**.

For example, when the vehicle which has been parked at an underground parking lot is driven to the outside, a graphic object indicating a communication connection state is output on the third region **113**, and parking lot-related information is output on the first region **111**. When the vehicle **100** driven out of the underground parking lot is in a GPS-connected state, the first region **111** and the third region **113** are moved toward the second region **112**. The second region **112** may be maintained in a state of displaying the driving information. The controller may increase brightness of the second region **112** so as to provide a feeling like three regions of a screen are combined into one.

When the vehicle **100** is driven from the outside into the underground, an image displayed may operate in the reverse order. For example, the driving information output on the second region **112** is divided into the first and third regions **111** and **113** and parking information related to each floor or parking-available place is displayed.

FIG. **11** illustrates an image which is displayed in response to a manipulation of a gearbox. A top drawing of FIG. **11** illustrates that a vehicle gear is placed at a forward movement direction, and a bottom drawing of FIG. **11** illustrates that the vehicle gear is placed at a backward movement position. According to this embodiment, image information projected on the windshield **110** may change based on a manipulation of a gear of the vehicle **100**.

For example, as illustrated in the top drawing, when the vehicle gear is placed at the forward movement position, a right-side image of the vehicle may be output on the first region **111** which is located at the right side based on the second region **112**, and a left-side image of the vehicle may be output on the third region **113** which is located at the left side based on the second region **112**. Meanwhile, a rear-side image of the vehicle may be output on the second region **112**. Accordingly, the user may acquire related information or image, even without viewing rearview mirrors for viewing left and right sides of the vehicle and a room mirror for viewing the rear side of the vehicle.

The image output may depend on a velocity of the vehicle. In other words, when the velocity of the vehicle is less than a predetermined velocity, camera images may be displayed. When the velocity of the vehicle becomes faster than the predetermined velocity, the camera images may be switched into driving information.

As illustrated in the bottom drawing, when the vehicle gear is placed at the backward movement position, the left-side image may be output on the first region **111**, the rear-side image of the vehicle on the second image **112**, and the right-side image of the vehicle on the third image **113**. In such a manner, the image information output on the second image **112** may change based on the gear manipulation of the vehicle **100**. Here, the image of the first region **111** and the image of the third region **113** may output the same image information, irrespective of the gear manipulation of the vehicle **100**.

The HUD device according to at least one embodiment having such configuration may be configured such that the backlight units which operate independent of one another can emit light to the display panel **220** in the different directions. This may allow more information to be provided through the display panel **220** with the same size. According to the embodiment disclosed herein, more information can be provided on the windshield, without the necessity of increasing the size of the HUD device. Therefore, a limited inner space of the vehicle can be utilized more efficiently.

The configurations and methods of the head-up display (HUD) device and the vehicle having the same in the aforesaid embodiments may not be limitedly applied, but such embodiments may be configured by a selective combination of all or part of the embodiments so as to implement many variations.

Therefore, an aspect of the detailed description is to provide a head-up display (HUD) device having a backlight module which has a different structure from the related art.

Another aspect of the detailed description is to provide a vehicle which is capable of providing information more efficiently through a windshield while being driven.

Another aspect of the detailed description is to allow a call and other image information to be output on a separate display region in a reception state (or receiving state) and in an information displayable state, such that driving information cannot be interrupted due to other received information.

As embodied and broadly described herein, there is provided a head-up display (HUD) device configured to project an image on a windshield, the head-up display device including a display panel, a backlight module that is configured to emit light to the display panel, and an optical guide module that is configured to guide an image displayed on the display panel to the windshield. The backlight module may include a plurality of backlight units that are configured to emit light to the display panel in different directions from one another, such that independent images are projected on different regions of the windshield.

The backlight module may include first and second backlight units that are disposed in one direction with being spaced apart from each other. The backlight module may include a third backlight unit that is disposed in an intersecting direction with the one direction with being spaced apart from the first and second backlight units.

A lens array may be provided between the display panel and the backlight module, so as to gather light emitted from the backlight units to the display panel. The optical guide module may include a main mirror that is configured to reflect an image displayed on the display panel to the windshield, and sub mirrors that are inclinedly disposed with respect to a central axis of the display panel. The first backlight unit may be disposed to overlap a center of the display panel, and the sub mirrors may be disposed on an optical axis of light emitted from the second backlight unit.

The head-up display device may further include a controller that is configured to control the backlight unit, and a communication unit that is configured to perform data transmission and reception with an external device. The communication unit may receive data from a mobile terminal. The controller may control at least one backlight unit based on global positioning system (GPS) information, and controls the other backlight units based on the data received from the mobile terminal.

As embodied and broadly described herein, there is provided a vehicle including a windshield, and a head-up display (HUD) device that is configured to project an image on the windshield. The head-up display device may include a display panel, an optical guide module that is configured to guide an image displayed on the display panel to the windshield, and a backlight module that is configured to emit light to the display panel in different directions from one another, such that independent images are projected on different regions of the windshield.

The backlight module may include a plurality of backlight units that are disposed with being spaced apart from one another. The images may include a plurality of images that are projected on the different regions of the windshield by the plurality of backlight units, respectively.

Each of the plurality of images may be image information belonging to a different category. The image information belonging to the different category may be related to information received from a different source.

The vehicle may further include a communication unit that is configured to perform data transmission and reception with an external device. One of the plurality of images may be image information related to driving, and another one of the plurality of images may be image information related to data received from the external device. The vehicle may further include a handle having a manipulation unit, and the communication unit may transmit a signal input through the manipulation unit to the external device. The vehicle may further include a voice recognition unit that is configured to recognize a user's voice, and the communication unit may transmit a signal input through the voice recognition unit to the external device.

The vehicle may further include a controller that is configured to control a backlight unit, which outputs an image in a direction corresponding to a turn signal, among the plurality of backlight units, in response to a turn-on of the turn signal. The controller may control image information displayed on the display panel based on data sensed by a detection sensor when the turn signal is turned on, the detection sensor being provided at at least one side of the vehicle to detect an object surrounding the detection sensor.

The image information projected on the windshield may be changeable based on a manipulation of a vehicle gear.

The vehicle may further include a controller that is configured to control the display panel, and the controller may change the image information displayed on the display panel in response to an operation of each of the plurality of backlight units. The controller may reduce an operating time of each of the plurality of backlight units when the number of display regions displayed on the windshield increases.

Any reference in this specification to "one embodiment," "an embodiment," "example embodiment," etc., means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one

embodiment of the disclosure. The appearances of such phrases in various places in the specification are not necessarily all referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with any embodiment, it is submitted that it is within the purview of one skilled in the art to effect such feature, structure, or characteristic in connection with other ones of the embodiments.

Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

What is claimed is:

**1**. A head-up display (HUD) device configured to project information as at least one of an image or text on a windshield, the head-up display device comprising:

a display panel;

a backlight module configured to emit light to the display panel, wherein the display panel modifies the light from the backlight module to form the information; and

an optical guide module configured to guide the information from the display panel to the windshield,

a communication module configured to receive data, and

a controller configured to control the backlight module,

wherein the backlight module includes a plurality of light sources configured to emit light to the display panel in different directions from one another such that parts of the information are independently projected on different regions of the windshield, the plurality of light sources being spaced apart from one another by a prescribed distance,

wherein a plurality of cameras are provided to capture images of different portions of a vehicle that includes the head-up display device,

wherein when a velocity of the vehicle is less than a predetermined velocity, the display panel generates a representation of the captured images of the different portions of the vehicle, and the controller is configured to control the plurality of light sources to emit light to the display panel such that the images of different portions of the vehicle are projected to the different regions of the windshield, and

wherein when the velocity of the vehicle is faster than the predetermined velocity, the display panel is configured to switch from generating the representation of the captured images to generating a representation of the received data, and the controller is configured to:

control a first light source of the plurality of light sources to emit light selectively to the display panel such that the representation of the received data generated by the display panel is projected to a first region of the windshield, and

control a second light source of the plurality of light sources to emit light selectively to the display panel such that the projected representation of the received data is moved from the first region to a second region of the windshield.

**2**. The head-up display device of claim **1**, wherein the optical guide module comprises:

a main mirror configured to reflect the information emitted by the display panel to the windshield; and

sub mirrors provided at inclined angles relative to a central axis of the display panel to direct projected information outputted by the display panel to the main mirror.

**3**. The head-up display device of claim **2**, wherein the inclined angles of the sub mirrors are adjustable, and wherein a displayed location of the information on the windshield changes based on adjusting the inclined angles of the sub mirrors.

**4**. The head-up display device of claim **2**, wherein a plurality of reflection mirrors are provided between the display panel and the main mirror to control light emitted from the display panel.

**5**. The head-up display device of claim **2**, wherein a light source of the plurality of light sources is positioned to output light to a center of the display panel, and

wherein the sub mirrors are provided on an optical axis of the light emitted from the light source.

**6**. The head-up display device of claim **1**, further comprising:

a lens array is provided between the display panel and the backlight module, wherein the lens array is configured to gather light emitted from the light sources and to direct the gathered light to the display panel.

**7**. The head-up display device of claim **1**, wherein the communication module receives data from a mobile terminal, and

wherein the controller controls at least one of the light sources based on global positioning system (GPS) information, and controls another at least one of the light sources based on the data received from the mobile terminal.

**8**. The head-up display device of claim **1**, wherein the plurality of light sources are spaced apart from one another in one direction or in two or more intersecting directions.

**9**. The head-up display device of claim **1**, wherein one of the light sources emits light to a portion of the display panel generating one category of information and another one of the light sources emits light to another portion of the display panel generating another category of information.

**10**. The head-up display device of claim **9**,

wherein the one category of information is related to an operation of the vehicle that includes the head-up display device, and

wherein the other category of information is related to the data received by the communications module.

**11**. The head-up display device of claim **1**, wherein the head-up display device is included in the vehicle that also includes a user input device, and wherein the communication module transmits input data received through the user input device to an external device.

**12**. The head-up display device of claim **1**, wherein the head-up display device is included in the vehicle that also includes a voice recognition module configured to recognize a user's voice, and wherein the communication module transmits data received through the voice recognition module to an external device.

**13**. The head-up display device of claim **1**, wherein the controller configured to control the light sources such that data identifying a direction of a turn signal is provided in a corresponding region of the different regions of the windshield.

**14**. The head-up display device of claim **1**, wherein the information projected on the windshield changes based on

manipulating of a gear shifting handle of a vehicle that includes the head-up display device.

**15**. The head-up display device of claim **1**, wherein the head-up display device is included in the vehicle that also includes a sensor to detect an object or person located within a proximity of the vehicle, and wherein the projected information includes data sensed by the sensor.

**16**. The head-up display device of claim **1**, wherein the controller further changes the information displayed on the display panel in response to selectively activating different ones of the plurality of light sources.

**17**. The head-up display device of claim **1**, wherein the controller operates two of the light sources in an alternating manner such at least a portion of the information is alternately provided on different regions of the windshield.

**18**. The head-up display device of claim **17**, wherein the controller selectively activates or deactivates a corresponding light source based on a change in the presented information.

**19**. The head-up display device of claim **17**, wherein the controller controls at least two portions of the display panel when the information is alternately provided on the different regions of the windshield.

**20**. A vehicle including a head-up display device according to claim **1**.

**21**. A mobile communication system including a head-up display device according to claim **1**.

**22**. The head-up display device of claim **1**, wherein:

the data received by the communication module includes driving path guide information related to a guide point,

the controller controls the first light source to emit light when the vehicle that includes the head-up display device moves within a first threshold distance of the guide point, and

the controller controls the second light source to emit light when the vehicle moves within a second threshold distance of the guide point, the second threshold distance being less than the first threshold distance.

**23**. The head-up display device of claim **1**, wherein when the vehicle is travelling in a first direction, two or more of the plurality of captured images are presented in respective first positions on the windshield, and

wherein when the vehicle is travelling in a second direction that differs from the first direction, the two or more of the plurality of captured images are presented in respective second positions on the windshield.

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